

## FIG.1

(a)

TRANSMITTING SIDE

CHANNEL CONDITION

5 (b)

SUBCARRIER

(c)

RECEIVING SIDE

## 10 FIG.2

TRANSMISSION DATA

12 MAPPING SECTION

13 PHASE ROTATION SECTION

14 IQ SEPARATION SECTION

15 15 IQ COMBINATION SECTION

16 INTERLEAVER

19 RADIO TRANSMISSION SECTION

RECEIVED DATA

20 29 DEMAPPING SECTION

28 PHASE ROTATION SECTION

26 IQ COMBINATION SECTION

25 IQ SEPARATION SECTION

27 DEINTERLEAVER

25 22 RADIO RECEPTION SECTION

## FIG.3

## TRANSMISSION DATA

- 102 MAPPING SECTION
- 103 PHASE ROTATION SECTION
- 104 IQ SEPARATION SECTION
- 5 105 IQ COMBINATION SECTION
- 106 INTERLEAVER
- 107 RANKING SECTION
- 108 INTERLEAVE PATTERN SETTING SECTION
- 109 INTERLEAVE INFORMATION INSERTION SECTION
- 10 111 PILOT SIGNAL INSERTION SECTION
- 113 RADIO TRANSMISSION SECTION

## RECEIVED DATA

- 212 DEMAPPING SECTION
- 15 211 PHASE ROTATION SECTION
- 210 IQ COMBINATION SECTION
- 208 IQ SEPARATION SECTION
- 209 DEINTERLEAVER
- 207 INTERLEAVE INFORMATION EXTRACTION SECTION
- 20 204 PILOT SIGNAL EXTRACTION SECTION
- 206 PROPAGATION PATH STATE ESTIMATION SECTION
- 202 RADIO RECEPTION SECTION

## FIG.4

- 25 MULTICARRIER TRANSMISSION APPARATUS

TIME

FIRST TRANSMISSION

SECOND TRANSMISSION

THIRD TRANSMISSION

REPORT OF PROPAGATION PATH INFORMATION AT FIRST  
TRANSMISSION

5 REPORT OF PROPAGATION PATH INFORMATION AT SECOND  
TRANSMISSION

MULTICARRIER RECEPTION APPARATUS

TIME

10 FIG.5A

SCALING FACTOR

FREQUENCY

FIG.5B

15 SUBCARRIER NUMBER

SCALING FACTOR VALUE 0

SCALING FACTOR RANKING

ASSIGNMENT OF TRANSMISSION SYMBOL ICH

ASSIGNMENT OF TRANSMISSION SYMBOL QCH DERIVED FROM

20 EXPRESSION (1)

ASSIGNMENT OF TRANSMISSION SYMBOL QCH WHEN INTERLEAVER  
WITH 2 SUBCARRIER SHIFTS IS USED

FIG.8

25 AVERAGE ERROR RATE  $P_e$

CONVENTIONAL

EMBODIMENT

AVERAGE NOISE POWER  $N[\text{dB}]$

FIG.9

TRANSMISSION DATA

- 5    102    MAPPING SECTION
- 103    PHASE ROTATION SECTION
- 104    IQ SEPARATION SECTION
- 105    IQ COMBINATION SECTION
- 106    INTERLEAVER
- 10    302    INTERLEAVE PATTERN TABLE
- 301    INTERLEAVE PATTERN SETTING SECTION
- 111    PILOT SIGNAL INSERTION SECTION
- 113    RADIO TRANSMISSION SECTION
- 109    INTERLEAVE INFORMATION INSERTION SECTION

15

RECEIVED DATA

- 212    DEMAPPING SECTION
- 211    PHASE ROTATION SECTION
- 210    IQ COMBINATION SECTION
- 20    208    IQ SEPARATION SECTION
- 209    DEINTERLEAVER
- 207    INTERLEAVE INFORMATION EXTRACTION SECTION
- 401    INTERLEAVE PATTERN TABLE
- 204    PILOT SIGNAL EXTRACTION SECTION
- 25    206    PROPAGATION PATH STATE ESTIMATION SECTION
- 202    RADIO RECEPTION SECTION

## FIG.10

## PROPAGATION PATH STATE ESTIMATION INFORMATION

302 INTERLEAVE PATTERN TABLE

301 INTERLEAVE PATTERN SETTING SECTION

5 106 INTERLEAVER

303 INTERLEAVER

304 ADDITION SECTION

305 VARIANCE CALCULATION SECTION

306 STORAGE SECTION

10 307 MINIMUM VALUE CALCULATION SECTION

109 INTERLEAVE INFORMATION INSERTION SECTION

## FIG.11

## TRANSMISSION DATA

15 102 MAPPING SECTION

103 PHASE ROTATION SECTION

104 IQ SEPARATION SECTION

105 IQ COMBINATION SECTION

106 INTERLEAVER

20 302 INTERLEAVE PATTERN TABLE

501 INTERLEAVE PATTERN SETTING SECTION

111 PILOT SIGNAL INSERTION SECTION

113 RADIO TRANSMISSION SECTION

109 INTERLEAVE INFORMATION INSERTION SECTION

25

## RECEIVED DATA

212 DEMAPPING SECTION

211 PHASE ROTATION SECTION  
 210 IQ COMBINATION SECTION  
 208 IQ SEPARATION SECTION  
 209 DEINTERLEAVER  
 5 207 INTERLEAVE INFORMATION EXTRACTION SECTION  
 401 INTERLEAVE PATTERN TABLE  
 204 PILOT SIGNAL EXTRACTION SECTION  
 206 PROPAGATION PATH STATE ESTIMATION SECTION  
 202 RADIO RECEPTION SECTION

10

FIG.12

PROPAGATION PATH STATE ESTIMATION INFORMATION

302 INTERLEAVE PATTERN TABLE  
 501 INTERLEAVE PATTERN SETTING SECTION  
 15 106 INTERLEAVER  
 502 INTERLEAVER  
 503 SUBTRACTION SECTION  
 504 ABSOLUTE VALUE ADDITION SECTION  
 505 STORAGE SECTION  
 20 506 MAXIMUM VALUE CALCULATION SECTION  
 109 INTERLEAVE INFORMATION INSERTION SECTION

FIG.13A

SNR VALUES IN SUBCARRIER UNITS MEASURED AT RECEIVER

25 SNR AREA NUMBER

THRESHOLD A

THRESHOLD B

SUBCARRIER

FIG.14A

SNR VALUES IN SUBCARRIER UNITS MEASURED AT RECEIVER

5 SUBCARRIER

FIG.15A

SNR VALUES IN SUBCARRIER UNITS MEASURED AT RECEIVER

SUBCARRIER HAVING VERY LOW SNR

10 THRESHOLD C

SUBCARRIER

FIG.15B

NOT SENT

15

FIG.16A

SNR VALUES IN SUBCARRIER UNITS MEASURED AT RECEIVER

SNR AREA NUMBER

THRESHOLD E

20 THRESHOLD D

SUBCARRIER

FIG.16D

NOT SENT

25

FIG.17

SNR VALUE RANKING ORDER ESTIMATED FROM FEEDBACK DATA

USE RANDOM INTERLEAVE  
 USE ADAPTIVE INTERLEAVE

FIG.18

- 5 PROBABILITY DENSITY  
 THRESHOLD D  
 THRESHOLD E  
 AREA WITH HIGH DIVERSITY EFFECT (SUBCARRIER WITH BAD  
 CHANNEL CONDITION)
- 10 AREA WITH LOW DIVERSITY EFFECT  
 AREA WITH HIGH DIVERSITY EFFECT (SUBCARRIER HAVING EXTRA  
 CAPACITY)

FIG.19

- 15 PER WHEN RANDOM INTERLEAVE IS PERFORMED  
 PER WHEN IDEAL INTERLEAVE IS PERFORMED  
 FREQUENCY OF TRANSMITTING FEEDBACK DATA  
 PER CHARACTERISTIC WHEN FEEDBACK IS PERFORMED ONCE EVERY  
 3 FRAMES
- 20 PER CHARACTERISTIC WHEN FEEDBACK IS PERFORMED ONCE EVERY  
 2 FRAMES  
 PER CHARACTERISTIC WHEN FEEDBACK IS PERFORMED EVERY FRAME  
 ONCE EVERY 3 FRAMES  
 ONCE EVERY 2 FRAMES
- 25 EVERY FRAME  
 CHANGE OF INTERLEAVE METHOD  
 USE ADAPTIVE INTERLEAVE



## USE RANDOM INTERLEAVE

## FIG.20

## TRANSMISSION DATA

- 5 102 MAPPING SECTION
- 602 SYMBOL ITERATION SECTION
- 103 PHASE ROTATION SECTION
- 104 IQ SEPARATION SECTION
- 603 INTERLEAVER
- 10 105 IQ COMBINATION SECTION
- 604 INTERLEAVER
- 107 RANKING SECTION
- 605 INTERLEAVE PATTERN SETTING SECTION
- 113 RADIO TRANSMISSION SECTION
- 15 111 PILOT SIGNAL INSERTION SECTION
- 109 INTERLEAVE INFORMATION INSERTION SECTION

## RECEIVED DATA

- 212 DEMAPPING SECTION
- 704 SYMBOL COMBINATION SECTION
- 20 211 PHASE ROTATION SECTION
- 210 IQ COMBINATION SECTION
- 702 DEINTERLEAVER
- 703 DEINTERLEAVER
- 208 IQ SEPARATION SECTION
- 25 207 INTERLEAVE INFORMATION EXTRACTION SECTION
- 202 RADIO RECEPTION SECTION
- 204 PILOT SIGNAL EXTRACTION SECTION

## 206 PROPAGATION PATH STATE ESTIMATION SECTION

FIG.21

ST1 FEEDBACK DATA (SNR VALUES IN SUBCARRIER UNITS)

5 SUBCARRIER

ST2 RANKING OF SNR VALUE IN DESCENDING ORDER

ST3 EVEN-NUMBER RANKING

ST4 ODD-NUMBER RANKING

ST5 EVEN-NUMBER RANKING (CHANGING IN ASCENDING ORDER)

10 ST11 ORIGINAL MODULATION SYMBOL

ST12 SYMBOL ITERATION WITH ITERATION COEFFICIENT 2

S1 (ITERATION)

S2 (ITERATION)

ST13 SET INTERLEAVERS FOR ICH AND QCH USING ODD-NUMBER

15 RANKING ORDER FOR ORIGINAL SYMBOLS S1, S2

ST14 SET INTERLEAVERS FOR ICH AND QCH USING EVEN-NUMBER

RANKING (ASCENDING ORDER OF SNR VALUES) FOR ITERATED S1

(ITERATION), S2 (ITERATION)

ST15 SPLICE INTERLEAVE PATTERN SET IN ST13 AND INTERLEAVE

20 PATTERN SET IN ST14

FIG.22

S1 MINIMUM VALUE OF DISTANCE BETWEEN SIGNAL POINTS

S1 (ITERATION)

25 MINIMUM VALUE OF DISTANCE BETWEEN SIGNAL POINTS

COMBINATION

$S1 + S1 (ITERATION)$

## MINIMUM VALUE OF DISTANCE BETWEEN SIGNAL POINTS

FIG.23

ST1 FEEDBACK DATA (SNR VALUES IN SUBCARRIER UNITS)

5 SUBCARRIER

ST2 RANKING OF SNR VALUE IN DESCENDING ORDER

ST3 EVEN-NUMBER RANKING

ST4 ODD-NUMBER RANKING

ST21 SYMBOL ITERATION OF ITERATION COEFFICIENT 2

10 S (ITERATION)

ST22 CREATE PLURALITY OF COMBINATIONS FOR ICH AND QCH  
SUBCARRIER ASSIGNMENT USING ODD-NUMBER RANKING ORDER FOR  
PHASE ROTATION CONSTELLATION

ST23 CREATE PLURALITY OF COMBINATIONS FOR ICH AND QCH  
15 SUBCARRIER ASSIGNMENT USING EVEN-NUMBER RANKING ORDER  
FOR PHASE ROTATION CONSTELLATION

ST24 SET INTERLEAVE PATTERN BY SIMULATING MINIMUM VALUE  
OF DISTANCE BETWEEN SIGNAL POINTS AFTER COMBINATION AT  
EACH COMBINATION

20

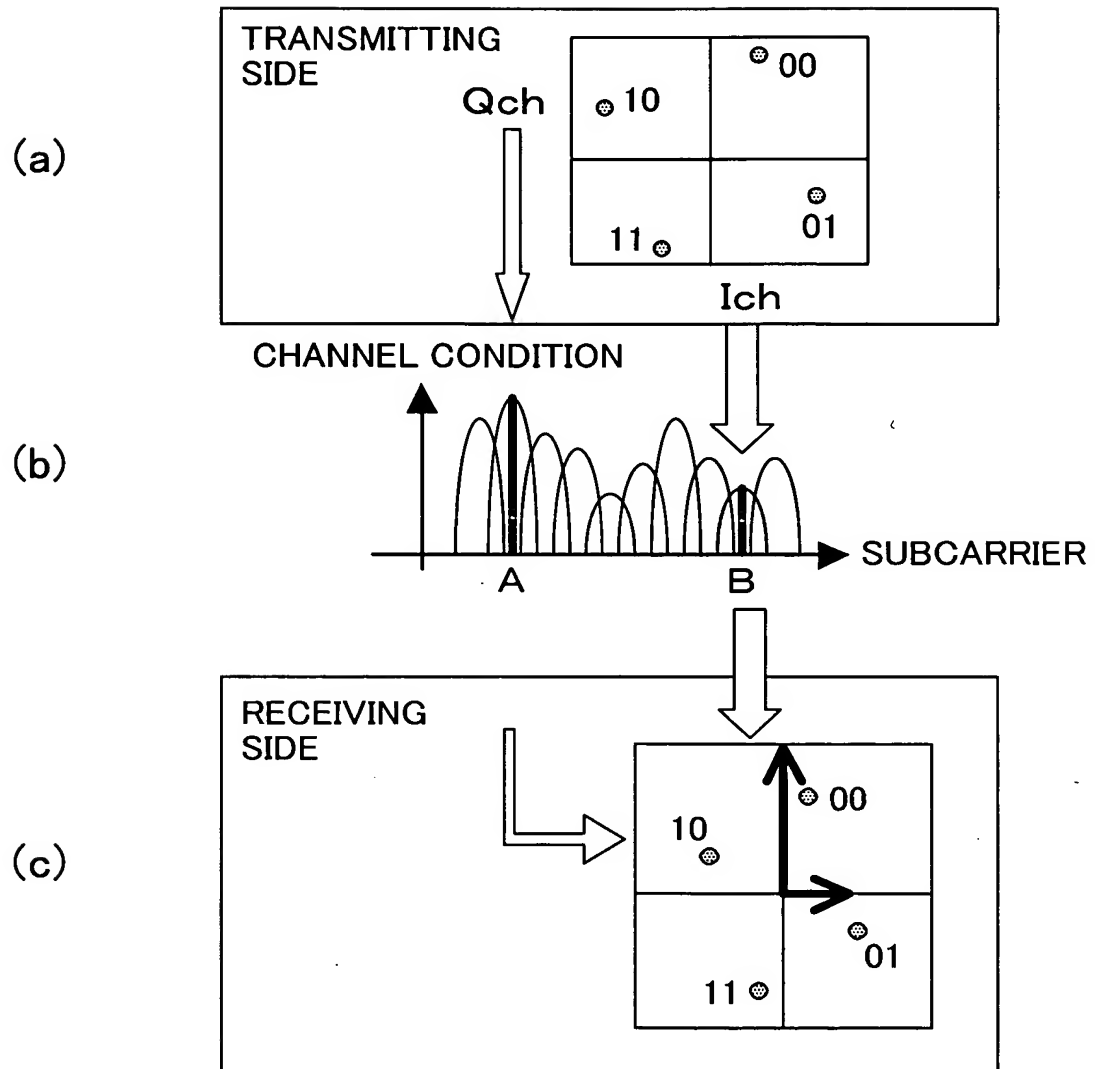


FIG.1  
(PRIOR ART)

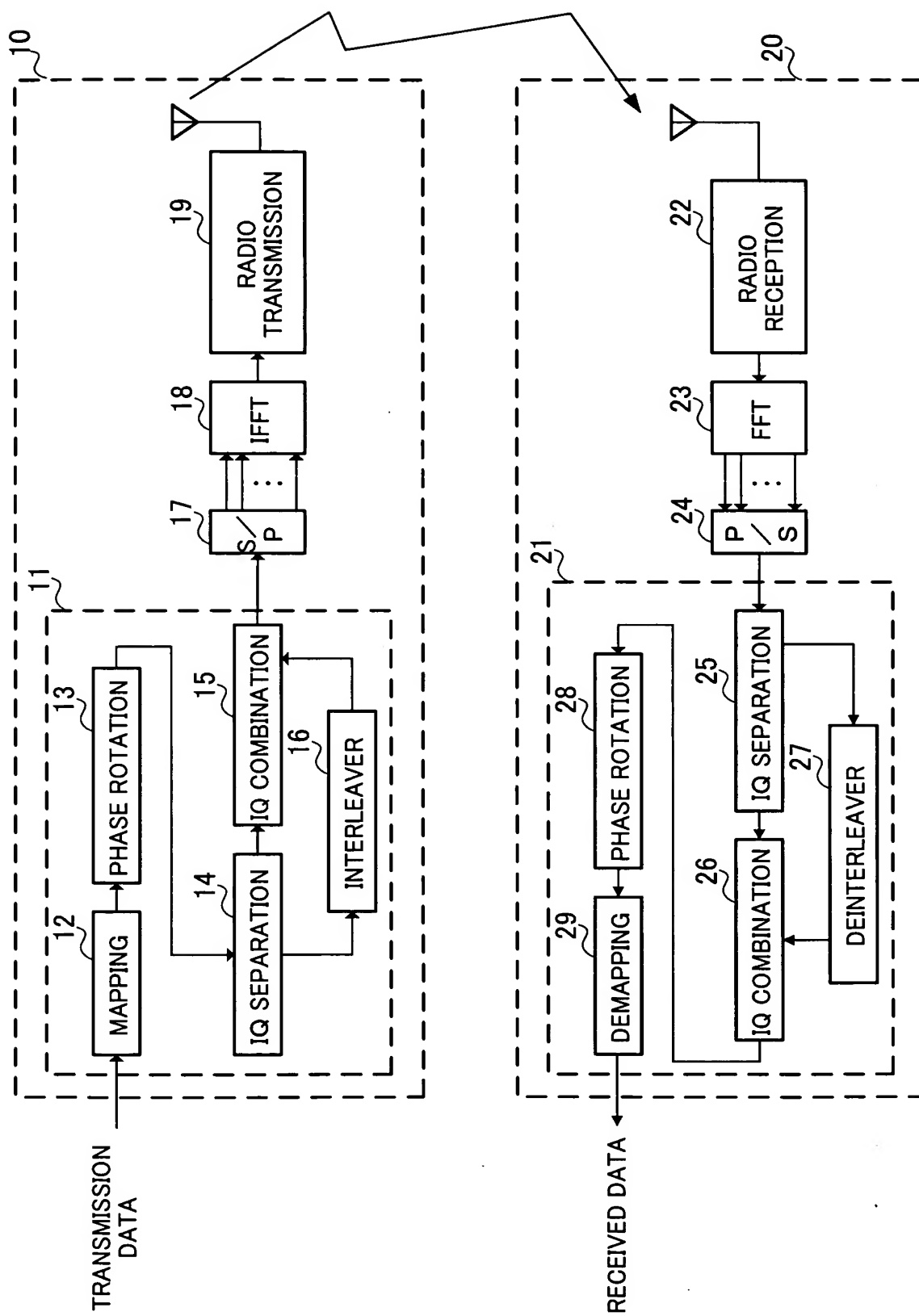


FIG.2 (PRIOR ART)

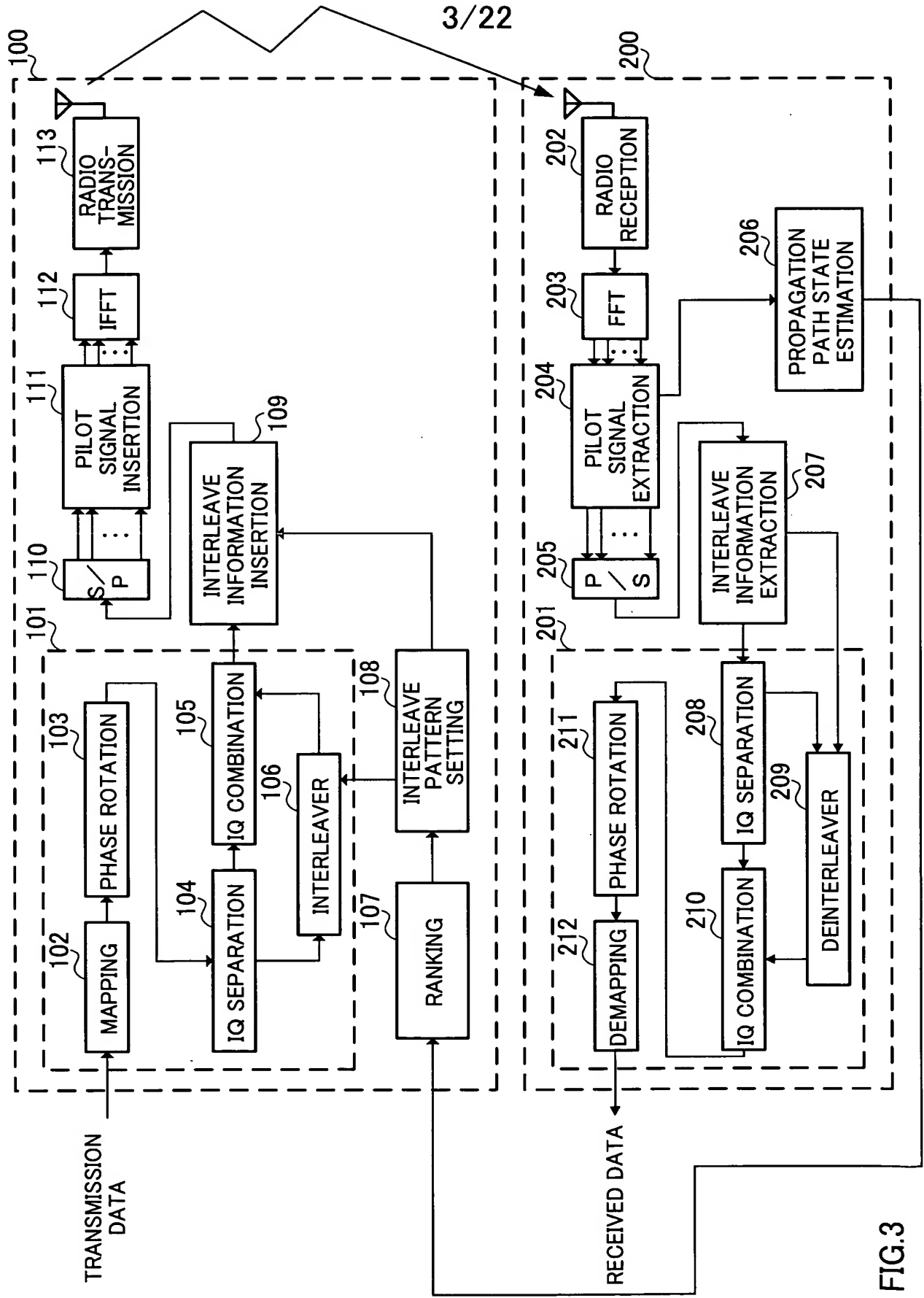


FIG.3

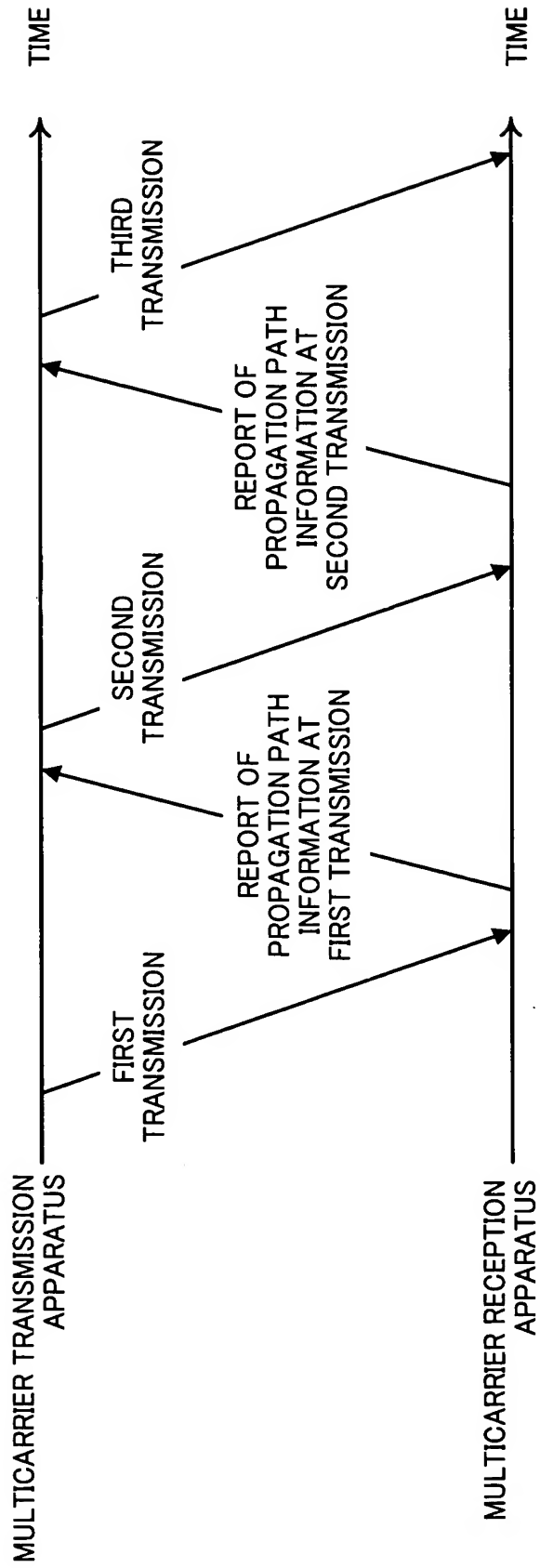


FIG.4

FIG.5A

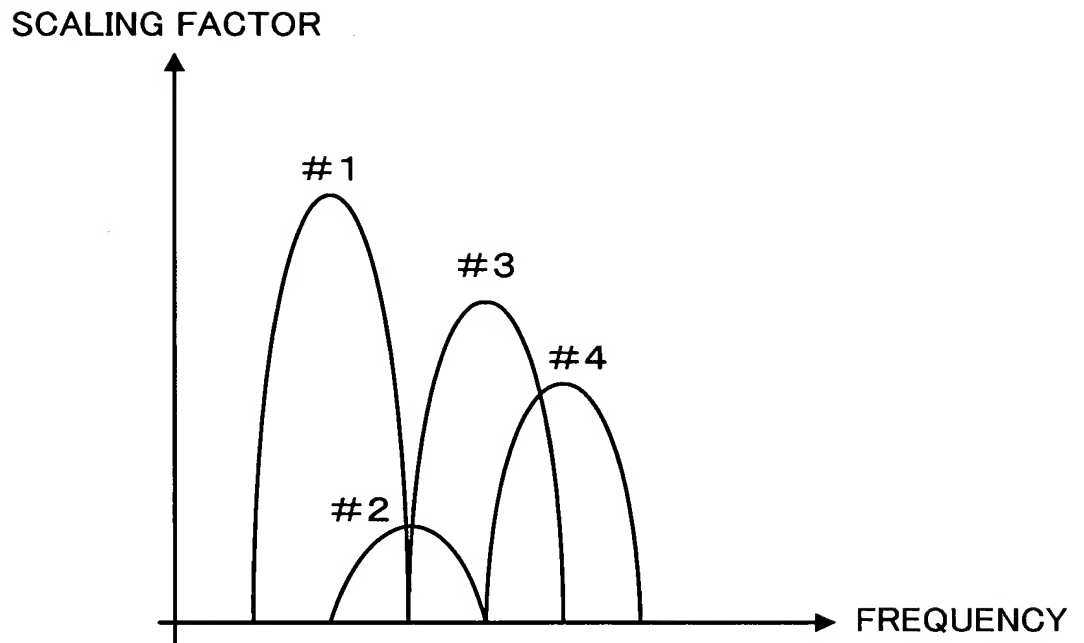


FIG.5B

SUBCARRIER NUMBER	#1	#2	#3	#4
SCALING FACTOR VALUE 0	5	1	3	2
SCALING FACTOR RANKING	1	4	2	3
ASSIGNMENT OF TRANSMISSION SYMBOL ICH	$i_1$	$i_2$	$i_3$	$i_4$
ASSIGNMENT OF TRANSMISSION SYMBOL QCH DERIVED FROM EXPRESSION (1)	$q_2$	$q_1$	$q_4$	$q_3$
ASSIGNMENT OF TRANSMISSION SYMBOL QCH WHEN INTERLEAVER WITH 2 SUBCARRIER SHIFTS IS USED	$q_3$	$q_4$	$q_1$	$q_2$



6/22

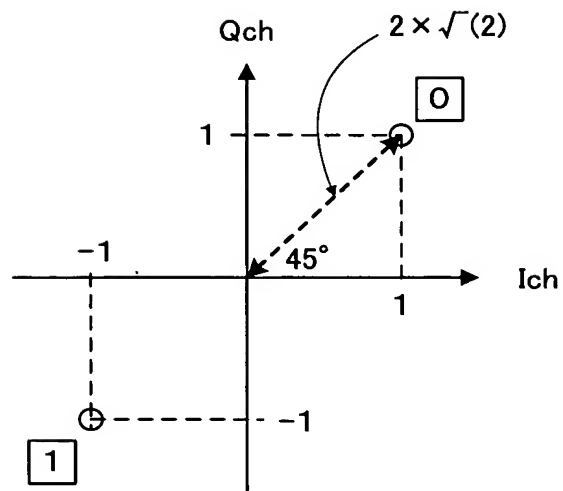


FIG. 6

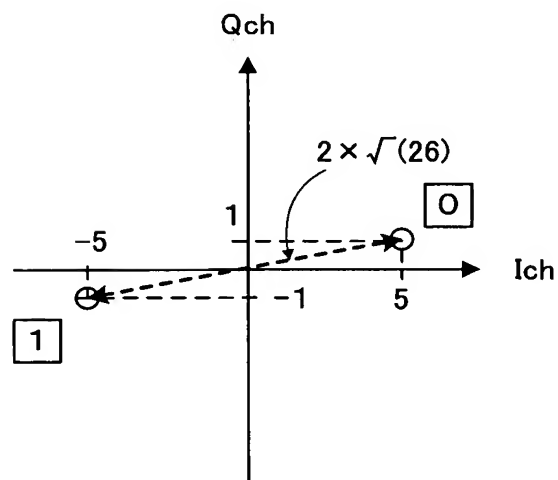


FIG. 7

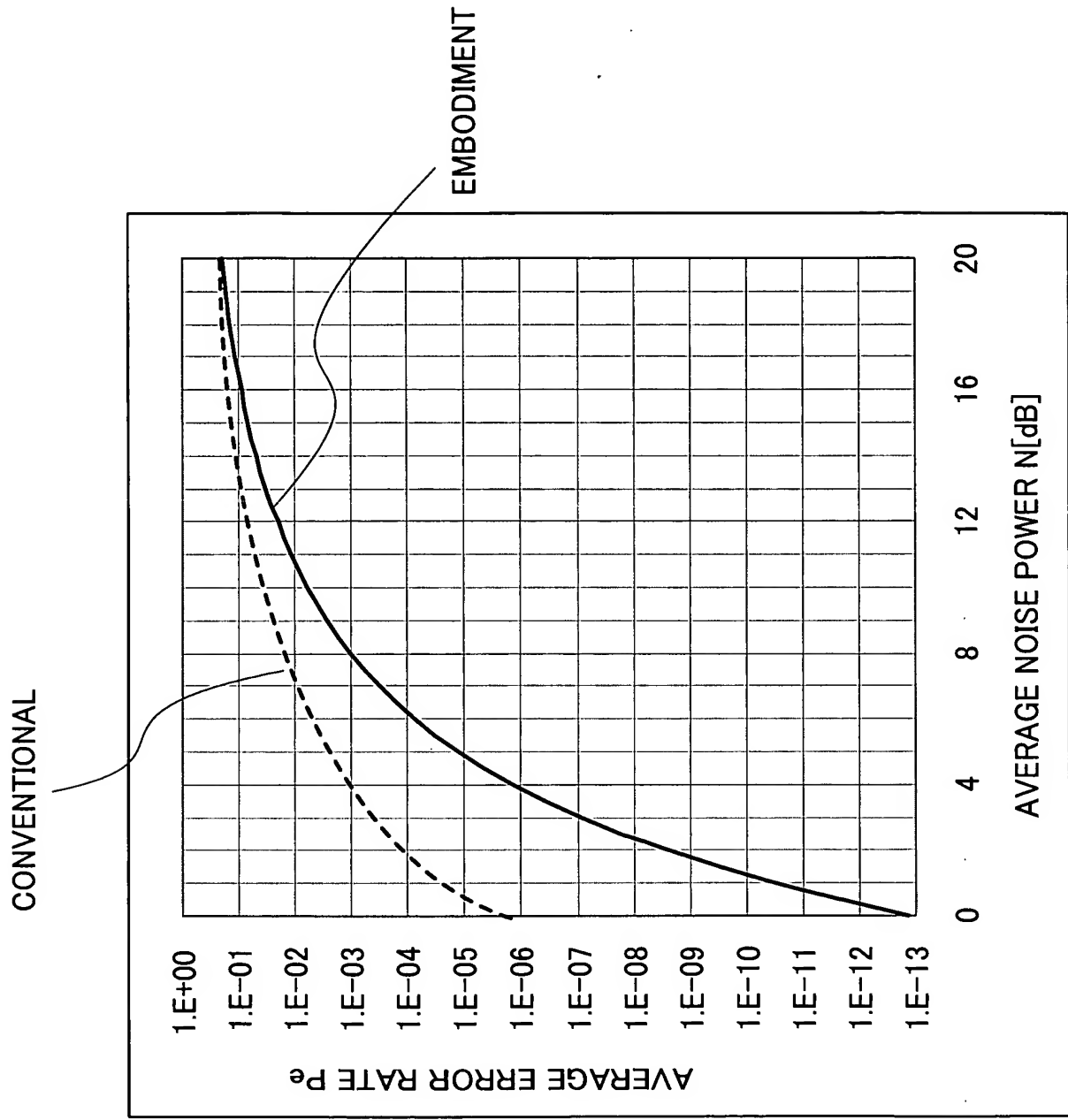


FIG.8

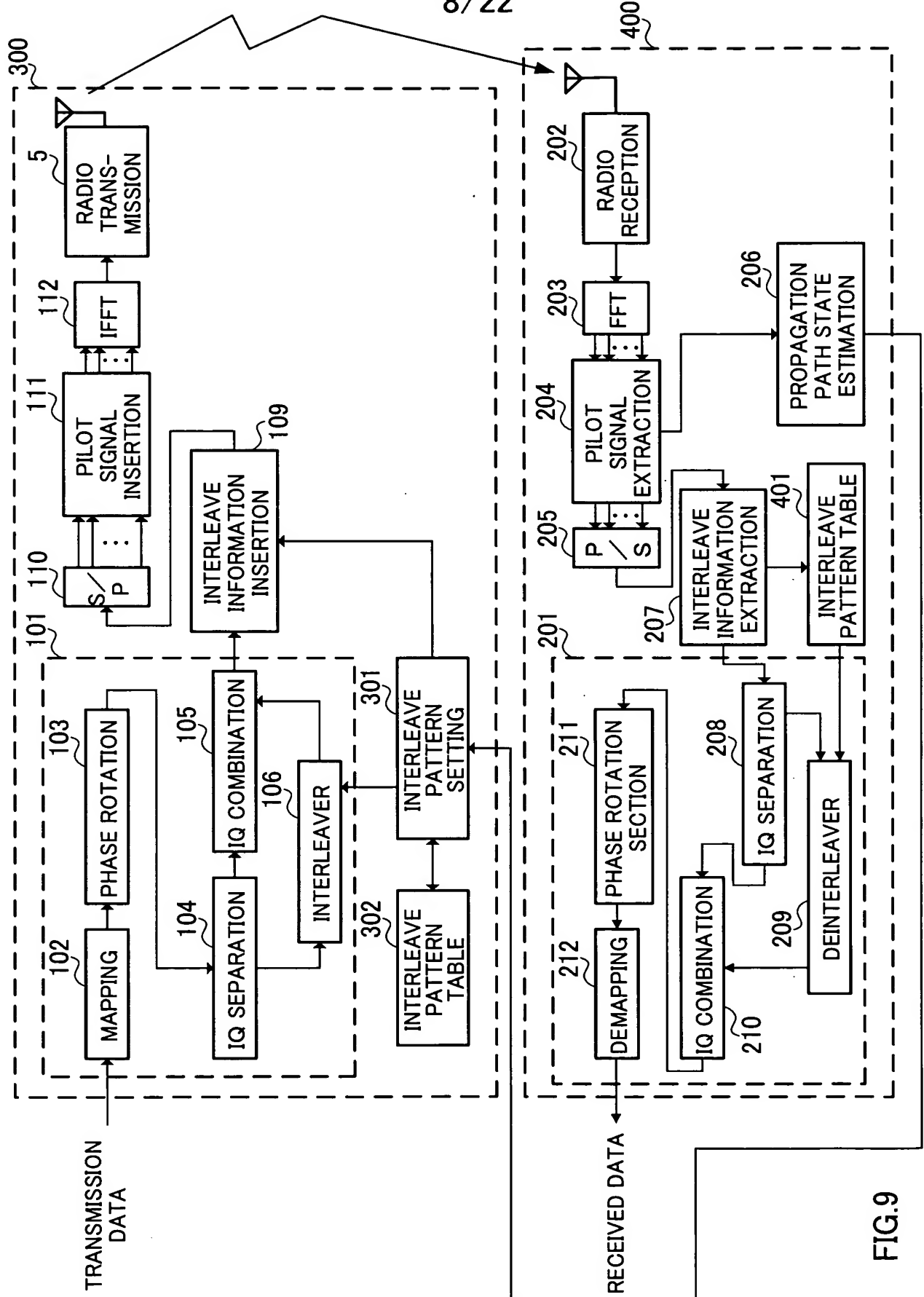


FIG. 9

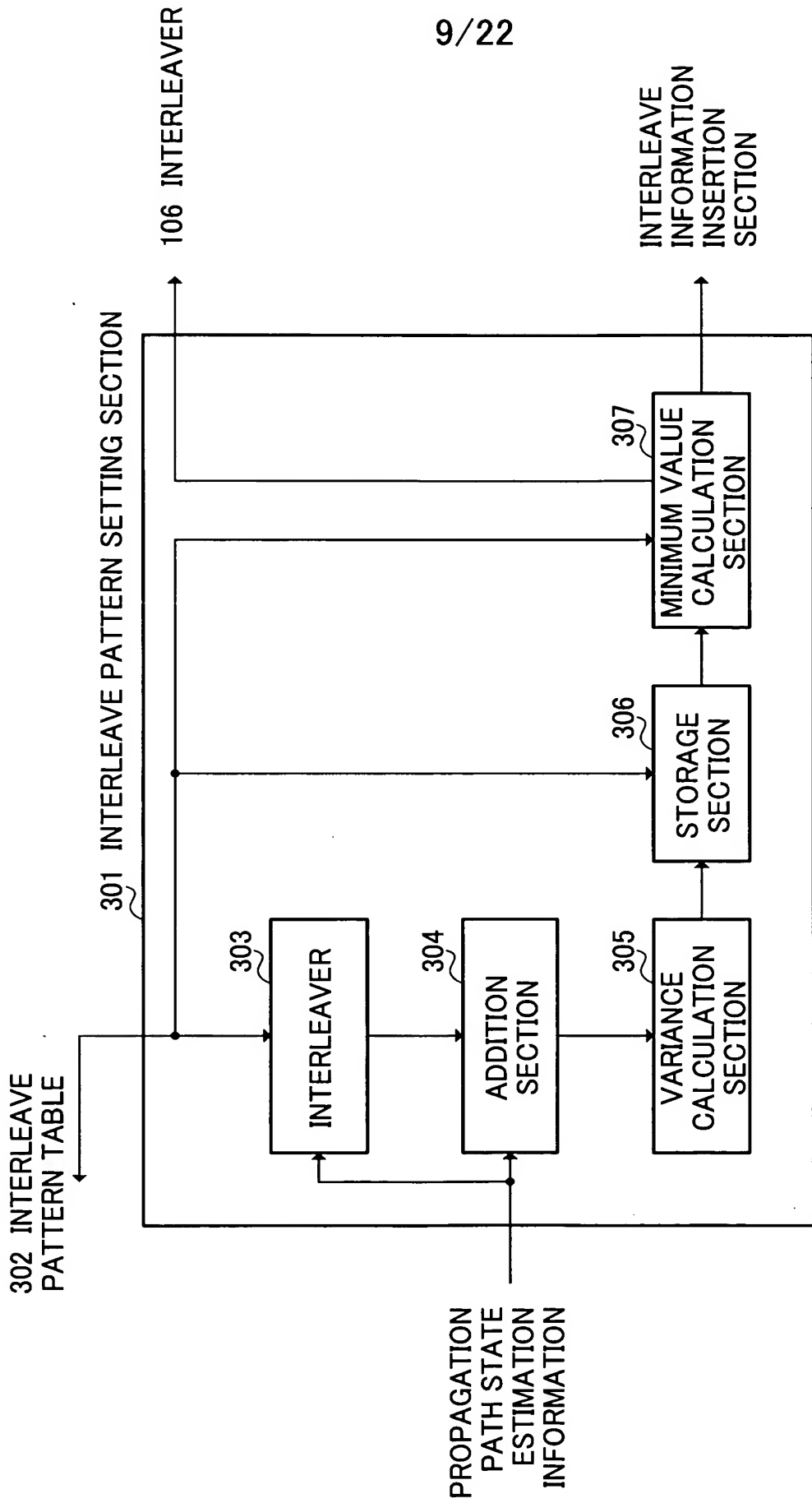


FIG.10

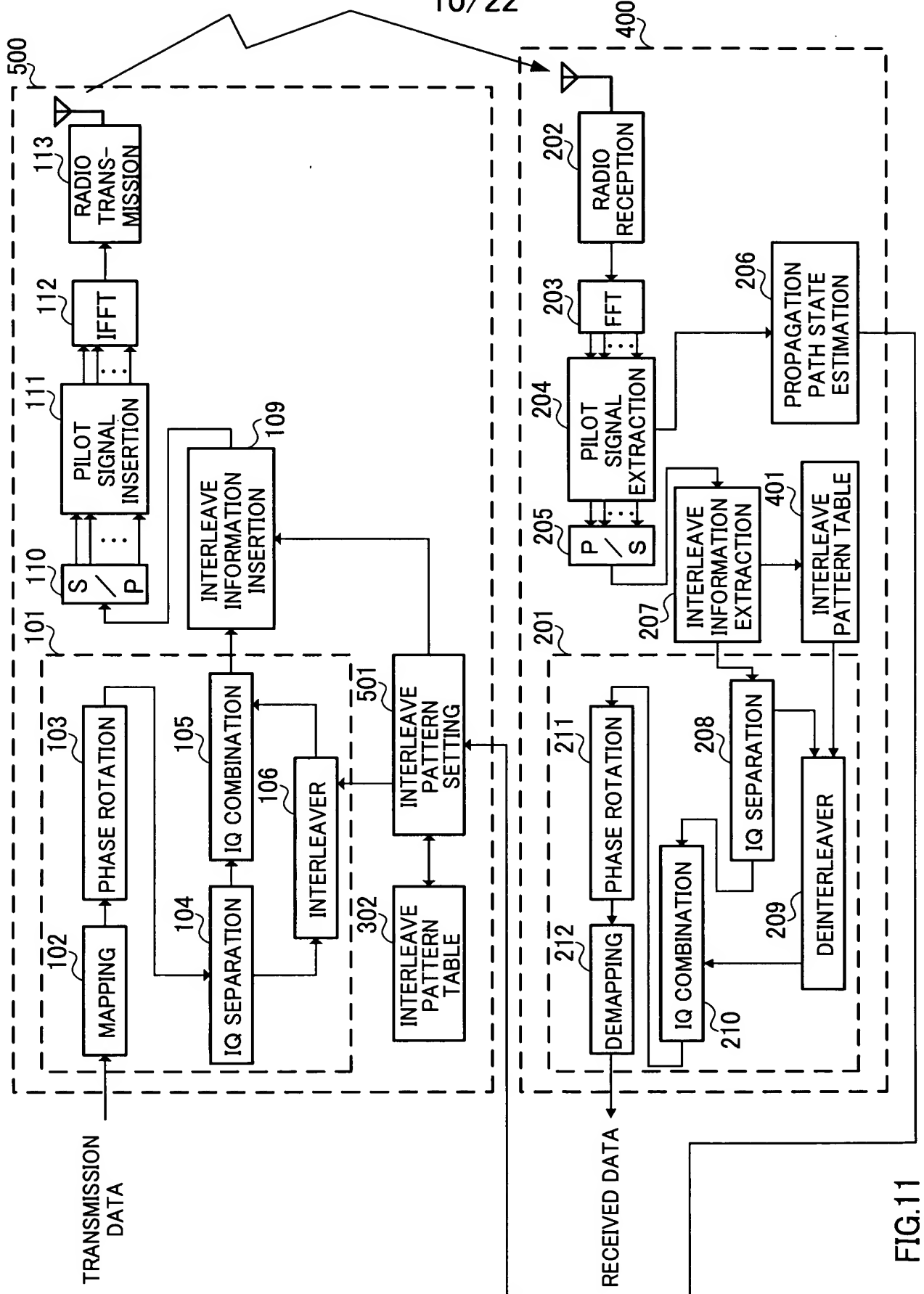


FIG.11

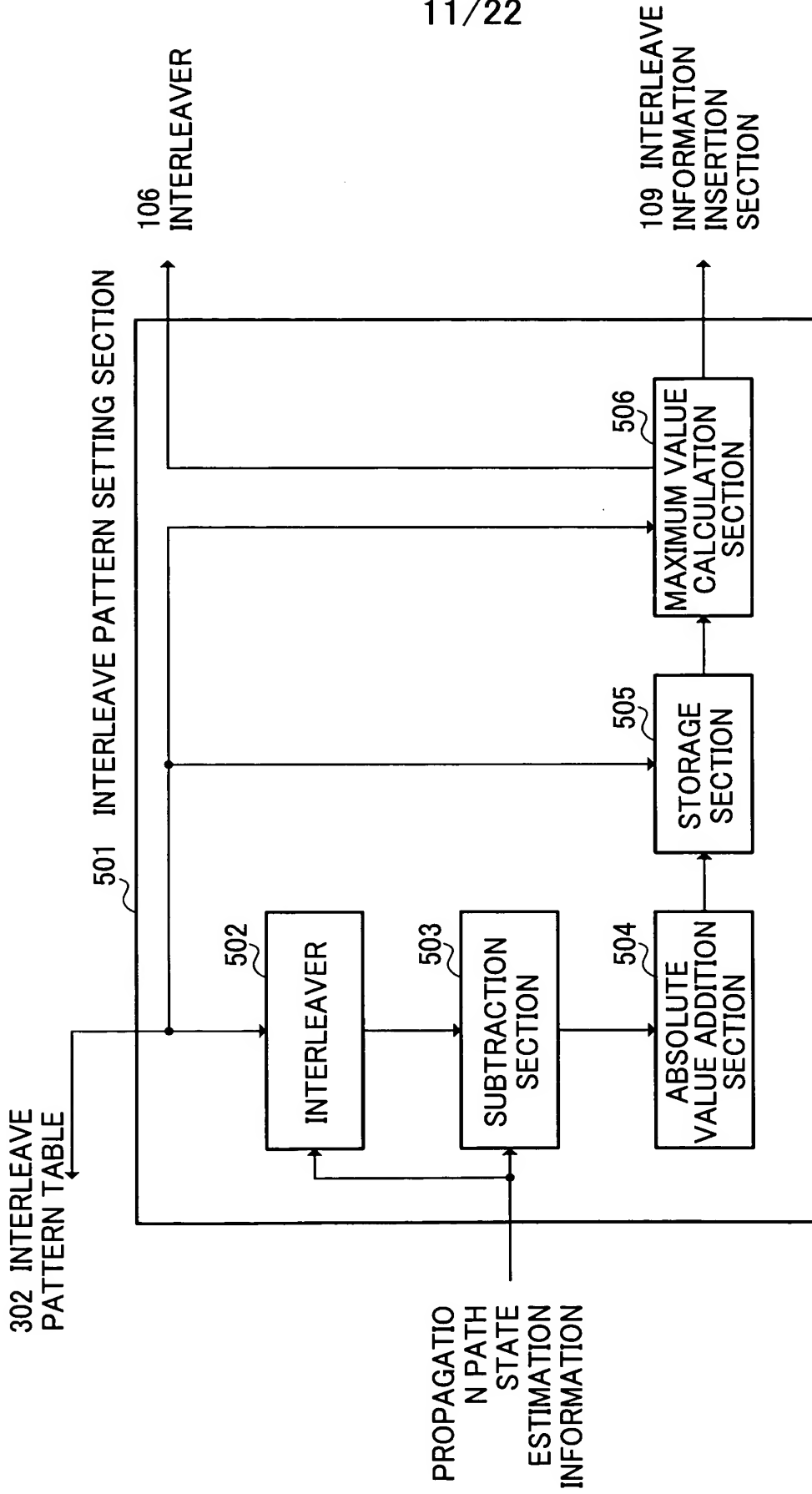


FIG.12

FIG.13A

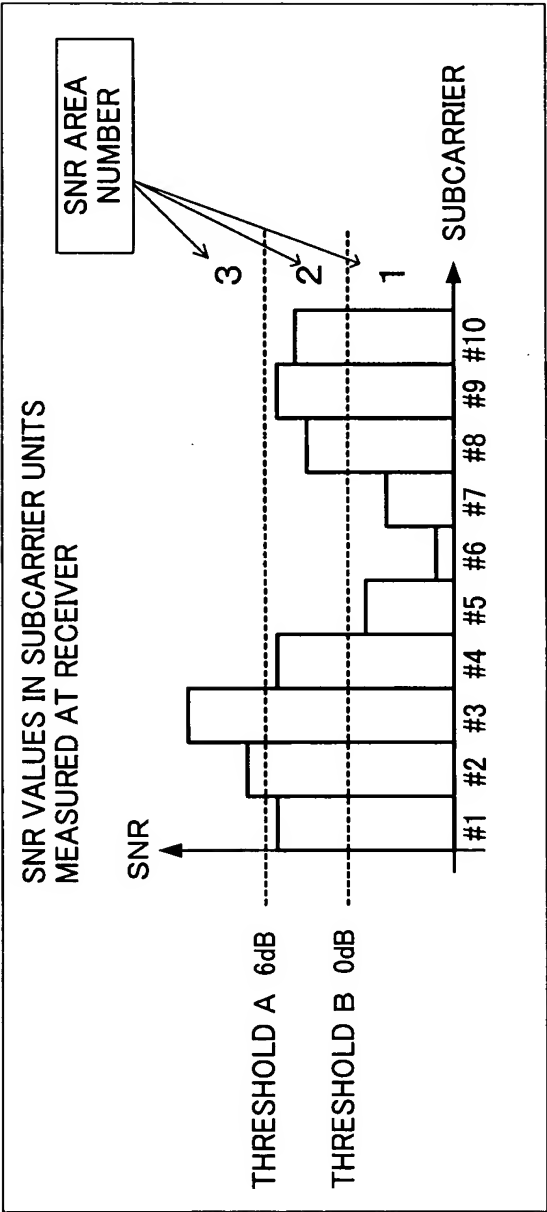


FIG.13B

#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
2	3	3	2	1	1	1	2	2	2

FIG.14A

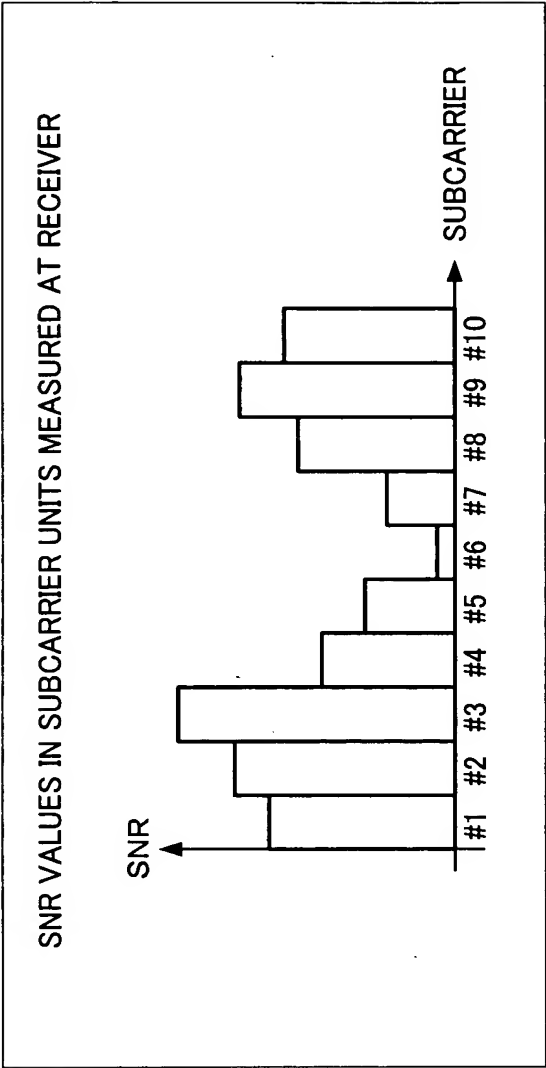


FIG.14B

1	2	3	4	5	6	7	8	9	10
#3	#2	#9	#1	#10	#8	#4	#5	#7	#6



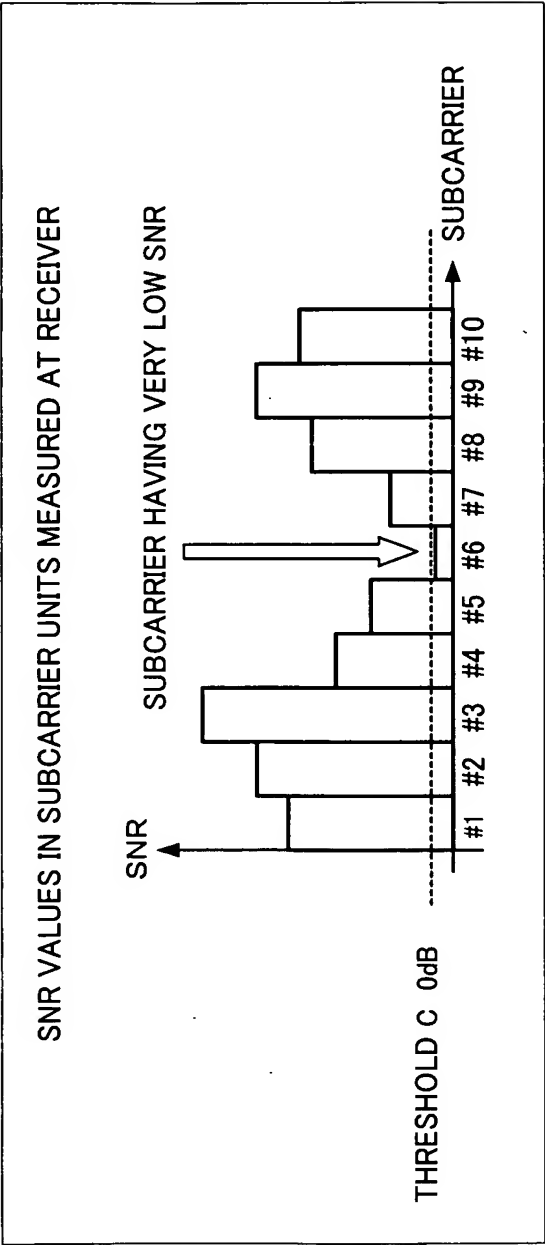


FIG.15A

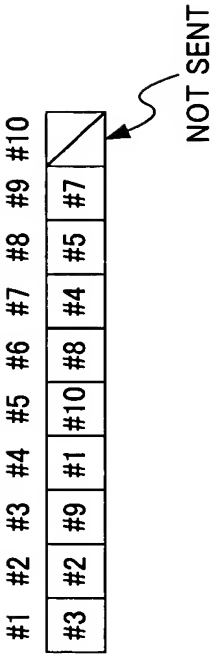


FIG.15B

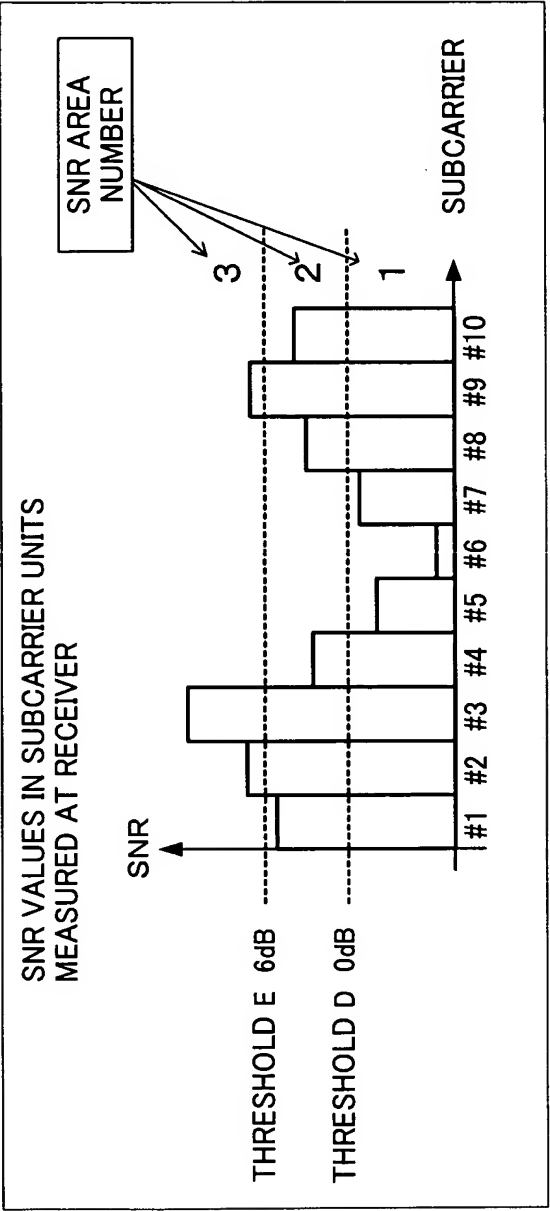


FIG.16A



FIG.16B

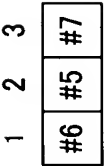


FIG.16C

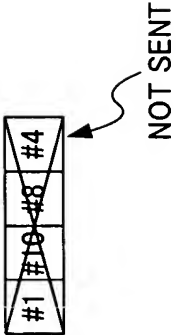


FIG.16D

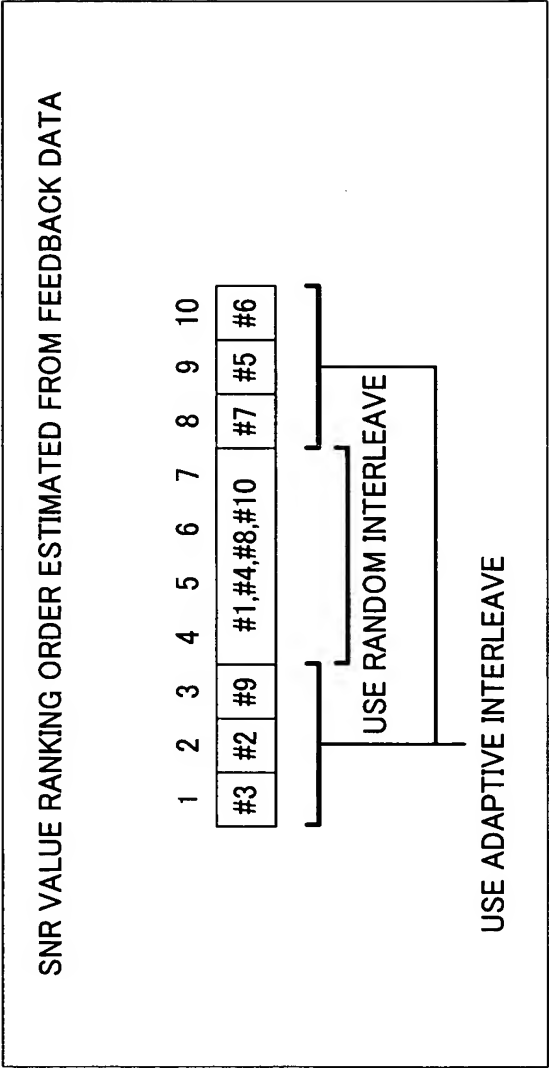


FIG.17

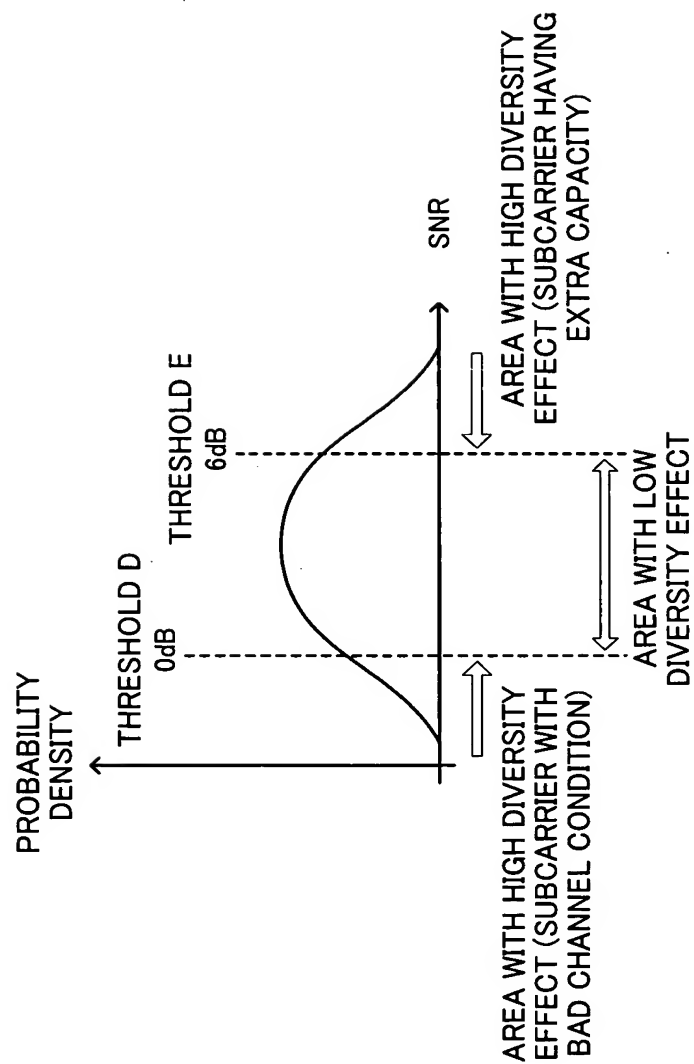


FIG.18

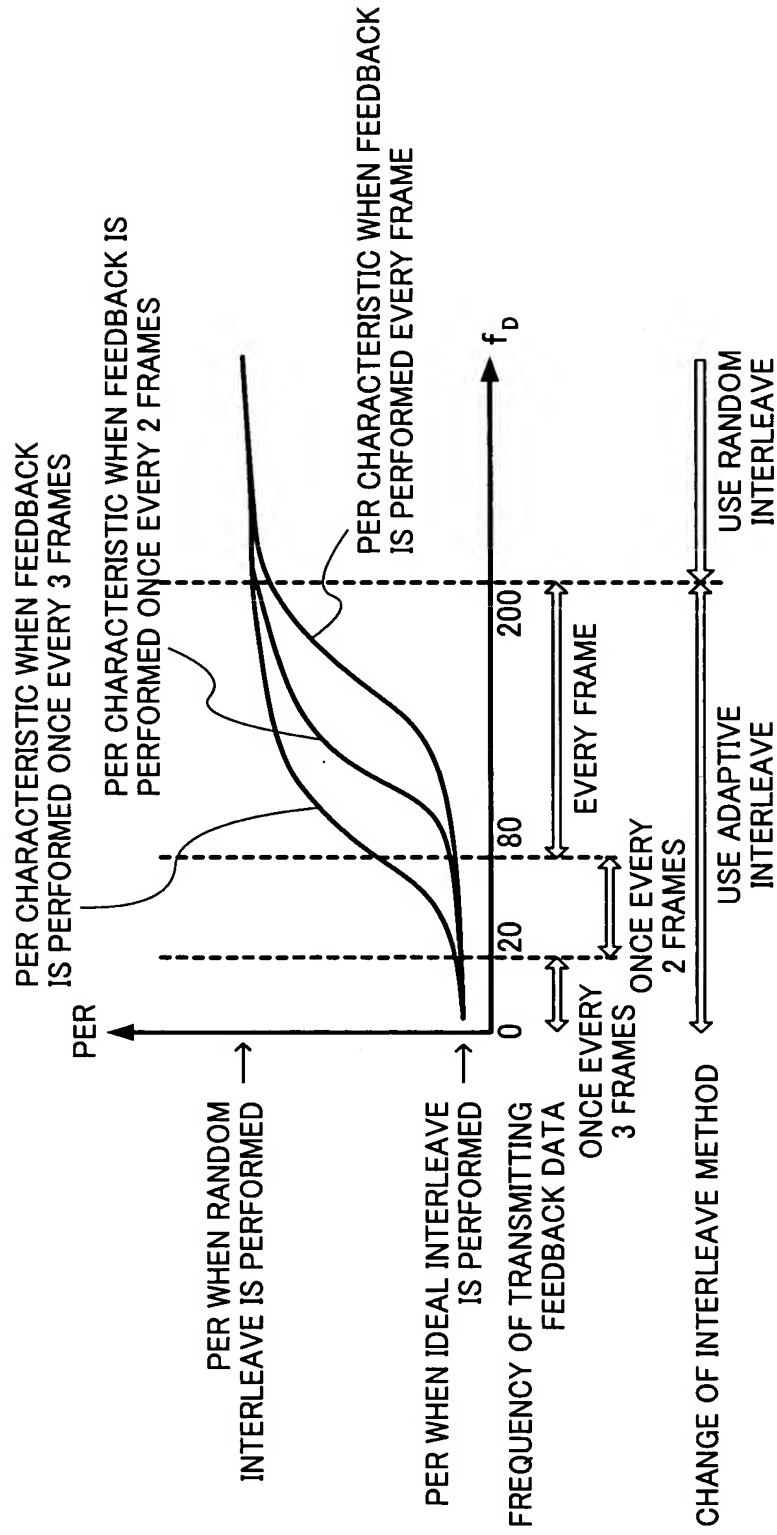


FIG.19

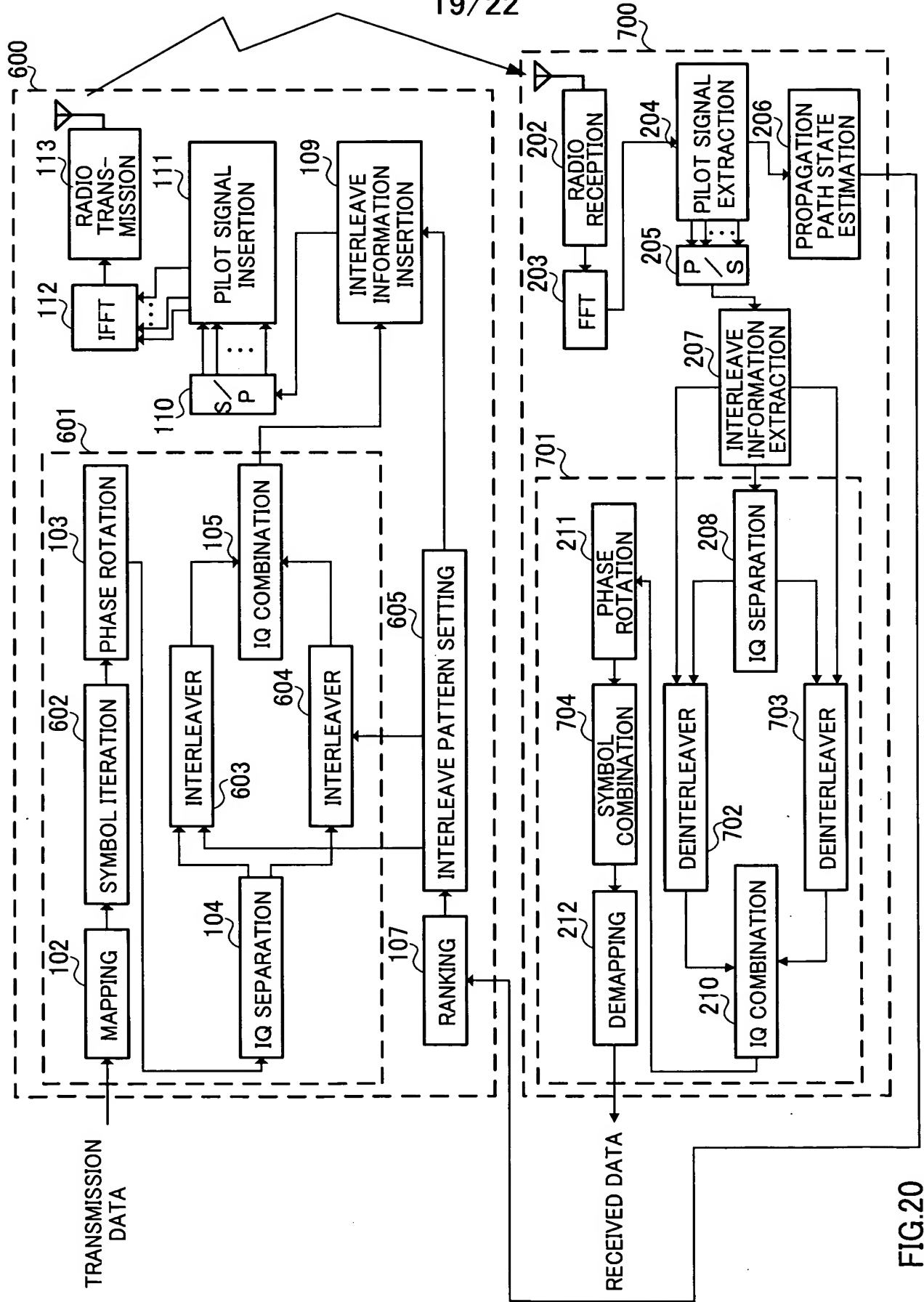


FIG. 20

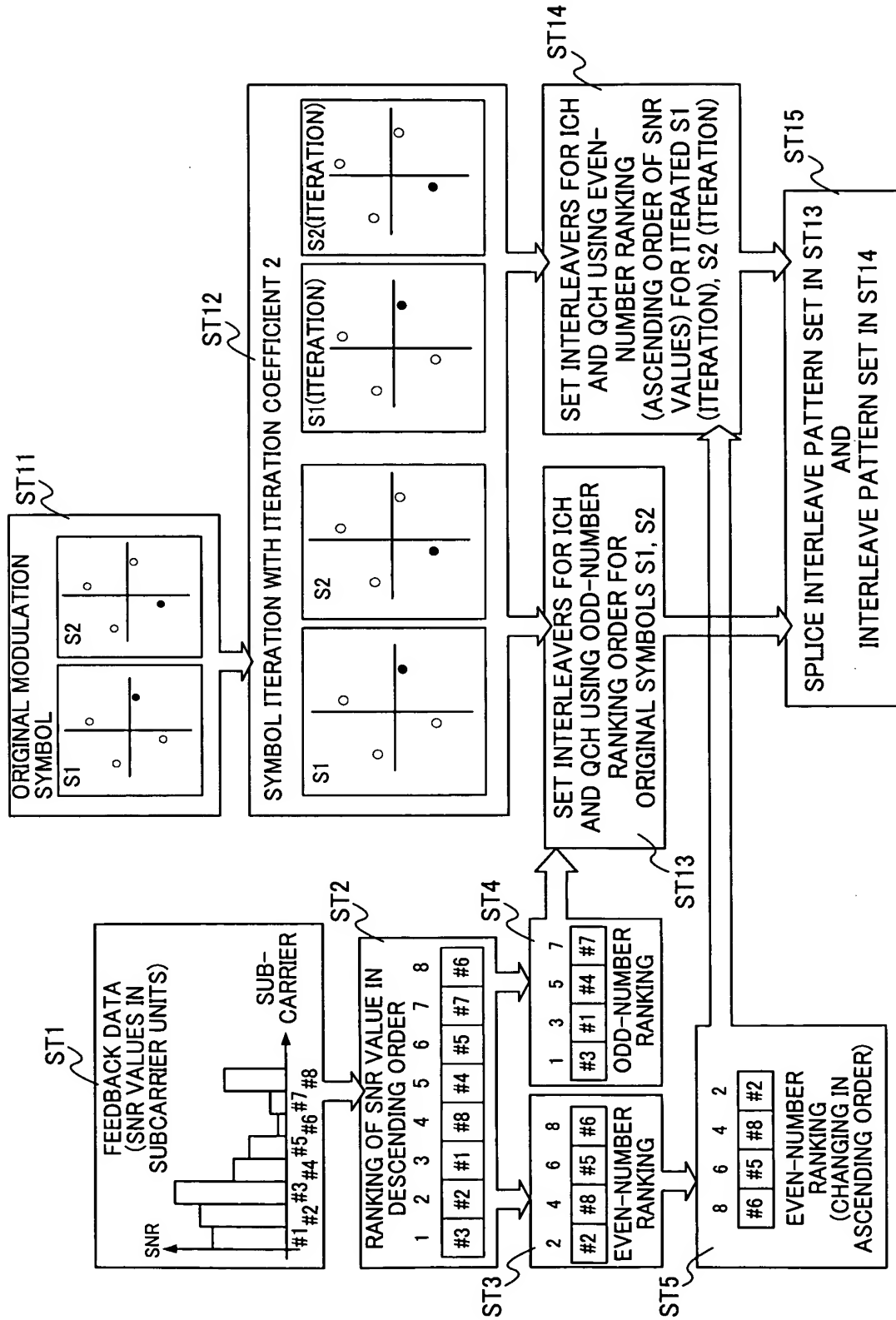


FIG.21

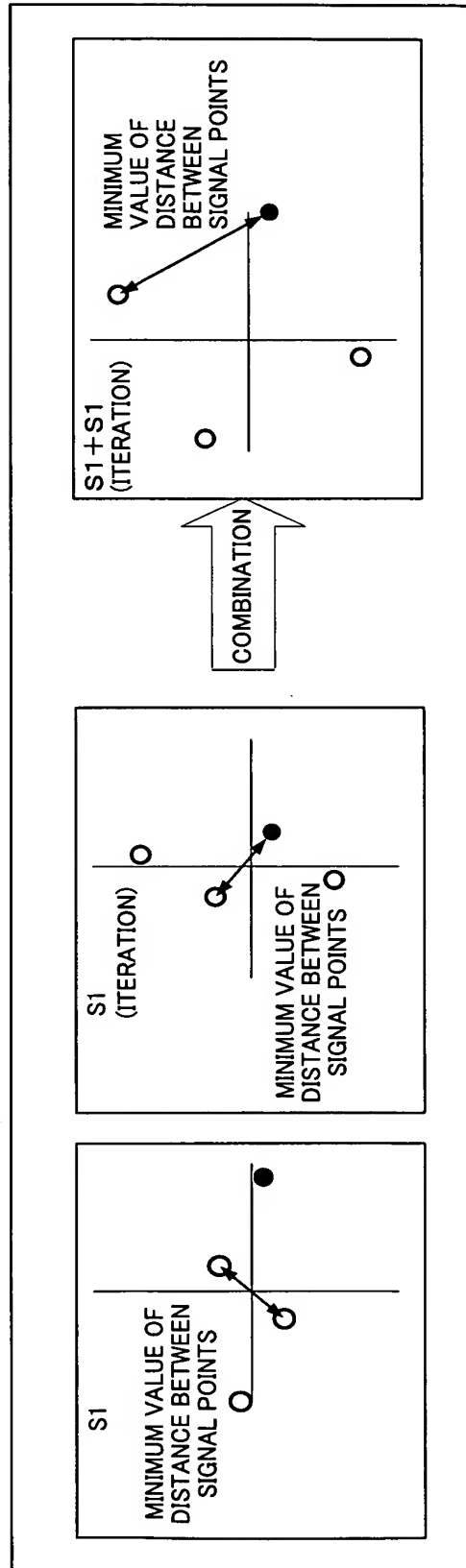


FIG.22



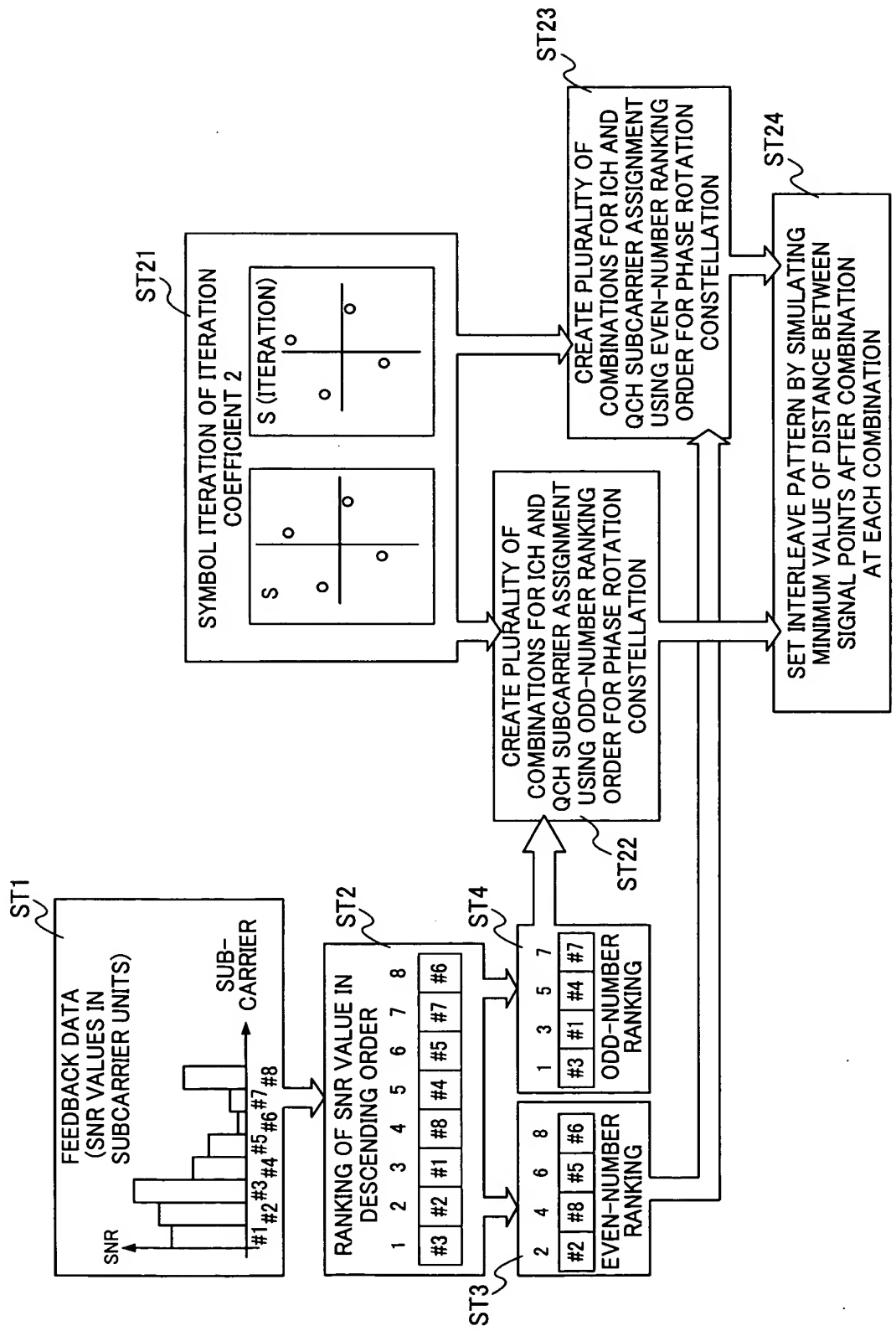


FIG.23